# CHAPTER 4

# PROCESS UNITS - SOURCE TESTING

# TABLE OF CONTENTS

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This chapter contains the test methods, procedures and source testing methodology necessary for a Facility Permit holder to establish an alternative emission factor for a $SO_x$ process.

## A. Test Methods

The Facility Permit holder shall source test each equipment using the following test methods and procedures referenced in the District Source Test Manual and 40 CFR Part 60, Appendix A:

### 1. Determinations and measurements prior to sampling:

a. Method 1.1 - sample points, stacks greater than 12 in. in diameter

b. Method 1.2 - sample points, stacks less than 12 in. in diameter

c. Method 2.1 - flow rate, stacks greater than 12 in. in diameter

d. Method 2.2 - flow rate, direct measurement

e. Method 2.3 - flow rate, stacks less than 12 in. in diameter

f. Method 4.1 - moisture

g. EPA Method 19 - calculated flow

### 2. Sulfur oxides concentration:

a. Method 100.1 - sulfur oxides, sulfur dioxide, carbon monoxide, carbon dioxide, and oxygen

b. Method 6.1 - for sulfur oxides in stack gas without ammonia present.

c. District Method 6.1 or Method 100.1 shall be used to determine $SO_2$ stack gas concentrations, if ammonia is not present in the stack gas. If ammonia is present in the stack gas, EPA Method 6 shall be used with the following modifications :

The sampling system shall be all borosilicate or quartz glass for any surface in contact with the sample gas up to the silica gel. No flexible tubing may be used between the probe and impingers or between impingers.

An in-stack filter holder, constructed of borosilicate glass or quartz glass, shall be used in place of a glass wool plug. The filter holder must provide a positive seal against leakage from the outside or around the filter. A high-efficiency glass fiber filter shall be used. The borosilicate or quartz glass probe shall

be heated and its temperature maintained at greater than 225 $^{o}$F.

Smith-Greenburg impingers shall be used instead of the midget impingers. The isopropanol impinger shall not be used. The first and second impingers shall contain 100 milliliters of 3% hydrogen peroxide, the third impinger shall be blank, and the fourth impinger shall contain silica gel.

The probe shall be washed separately with 3% hydrogen peroxide and analyzed separately from the impingers. The results of the two analyses shall be summed to provide a total $SO_2$ catch.

All samples shall be treated with an ion exchange resin for $NH_3$ interference. The ion exchange resin shall be Rexyn-R or equivalent.

d. Method 307.91 - for total sulfur compounds in fuel gas

**3. Oxygen concentration:**

a. Method 3.1 - molecular weight and excess air correction factor.

b. Method 100.1 - sulfur oxides, sulfur dioxide, carbon monoxide, carbon dioxide and oxygen

## B. Number of tests

To establish an alternative emission factor, a minimum of three separate tests shall be run at each condition throughput that the equipment is expected to operate. Each set of tests shall cover the different operating conditions of the cycle in sequence. The cycle shall be repeated in the same manner for the next set of tests.

## C. Testing frequency

The Facility Permit holders of major $SO_x$ sources shall source test as part of their quality assurance program. Process units shall be source tested every time the Facility Permit holder applies for an alternative emission factors.

## D. Sampling time and test procedures

1. For boilers, heaters, IC engines, turbines - tests shall be conducted at low, medium and high load. The same sequence of operating conditions should be followed for each separate test, with each test condition being monitored for a minimum of 15 minutes.

2. Furnaces, kilns, dryers, calciners and ovens, operating continuously, shall be monitored for a minimum of 30 minutes, for each testing condition. For non-continuous operations (i.e. batch) samples shall be

taken for each phase of the operation (i.e. metal furnace charging, fluxing, melting, sweating and taping), for a minimum of 15 minutes or as long as the phase lasts. Data shall be submitted on the time that it takes to complete each phase, and the emissions for the total cycle shall be calculated based on the time required to complete each phase and the emissions measured during the corresponding phase.

3. Incinerators and afterburners shall be monitored for a minimum of 15 minutes at each operating temperature and at each flow rate.

4. Engine test cells shall be monitored over the total cycle if it lasts less than 30 minutes. Otherwise monitor for 15 minutes at each engine test condition, or the total time if less than 15 minutes.

5. For the equipment not included above, an individual test plan shall be submitted for approval by the Executive Officer. This plan shall include justification on how the measurements shall quantify equipment emissions.

## E. Guidelines for Testing to Establish an Alternative Emission Factor

1. For process units the Facility Permit holder has the option of having an equipment-specific or category-specific emission factor based on the average fuel sulfur content is determined from the source test. The average fuel sulfur content or equipment-specific or category-specific emission factor shall be used to determine compliance with the facility's allocations.

2. In order to establish an alternative emission factor for the process unit without post-combustion control equipment, the fuel sulfur content shall be measured once per week over a quarterly period. This quarterly measurement shall be required whenever an alternative emission factor is established. If the process unit burns the fuel of which the sulfur content is treated prior to the combustion, the sulfur content shall be source tested at the downstream of the sulfur treatment system. After the measured data set succeeding the confidence interval test described in Chapter 6, Subdivision E, Paragraph 6, the average sulfur content shall be converted into alternative emission factor using equations provided in Chapter 6, Subdivision E, Paragraph 4.

3. In order to establish an alternative emission factor for the process until with post-combustion control equipment, the exhaust $SO_X$ concentration shall be source tested at the downstream of the control equipment at four different representative operating conditions of the proposed process unit. Such testing shall be done at least three times at each condition, but not consecutively. After the measured data set succeeding the confidence interval test described in Chapter 6, Subdivision E, Paragraph 6, the average stack concentration shall be converted to the alternative emission factor using the equations provided in Chapter 6, Subdivision E, Paragraph 5.

4. For process unit without post-combustion equipment, an average fuel sulfur content that satisfies the confidence interval test described in

Chapter 6, Subdivision E, Paragraph 6, shall be converted into an alternative emission factor by the following equation:

For gaseous fuels,

$$EF_k = C_{kg} \times 0.166 \quad \text{(Eq.23)}$$

or

$$EF_k = C_{kl} \times 2.86 \quad \text{(Eq.24)}$$

For liquid fuels,

$$EF_k = C_{kl} \times S_l \times 166 \quad \text{(Eq.25)}$$

where:

$EF_k$ = The fuel specific alternative emission factor for gaseous or liquid fuel (lb/mmscf or lb/mgal).

$C_{kg}$ = The average fuel sulfur content of gaseous fuel determined form Eq. 28 in Chapter 6, Subdivision E, Paragraph 6 (ppmv).

$C_{ka}$ = The average fuel sulfur content of gaseous fuel determined form Eq. 28 in Chapter 6, Subdivision E, Paragraph 6 (grain/100ft$^3$).

$C_{kl}$ = The average fuel sulfur content for gaseous fuel determined from Eq. 28 in Chapter 6, Subdivision E, Paragraph 6 (percent by weight).

$s_l$ = The specific gravity of liquid fuel.

k = The different type of fuel.

Example Calculations:

(a) Alternative emission factor for process unit without post-combustion control equipment,

A 5 mmbtu/hr boiler burns natural gas. The average sulfur content of the gaseous fuel is 30 ppmv.

$EF_k = C_{kg} \times 0.166$

$EF_k = (30)(0.166)$

$= 4.98$ lb/mmscf of $SO_X$ emission factor

(b) Alternative emission factor for process unit without post-combustion control equipment, but with pre-combustion sulfur treatment system

A 500 bhp ICE burns Diesel Oil. The specific gravity of the liquid fuel is 0.82. The average sulfur content determined after confidence interval test came out to be 0.05% by weight, which is the treated sulfur content.

$EF_k = C_{kl} \times S_l \times 166$

$= (.05)(.82)(166)$

$= 6.806$ lb/mgal of $SO_X$ emission factor

5. For process unit with control equipment, the exhaust $SO_X$ concentration and exhaust oxygen or stack exhaust flow rate shall be source tested at downstream of the control equipment and shall be converted to an alternative emission factor by one of the following equation:

when the exhaust oxygen is source tested,

$$EF_{ki} = PPMV_i \times (20.9/20.9\text{-}b) \times 1.662 \times 10^{-13} \times F_d \times V \quad \text{(Eq.26)}$$

when the stack exhaust flow rate is source tested,

$$EF_{ki} = PPMV_i \times (C/d) \times 1.662 \times 10^{-7} \quad \text{(Eq.27)}$$

where:

$EF_{ki}$ = The fuel-specific alternative emission factor as specified in the Facility Permit (lb/mmscf for gaseous fuel or lb/mgal of liquid fuel)

k = Each type of fuel.

i = Each data source tested at each operating condition.

PPMV = The stack concentration of $SO_X$ (ppmv).

b = The exhaust oxygen concentration determined from the source test (%).

$F_d$ = The dry F factor for each type of fuel, the ratio of the dry gas volume of the products of combustion to the heat content of the fuel (dscf/$10^6$ Btu).

V = The higher heating value of the fuel for each type of fuel.

C = The exhaust flow rate of the stack determined from the source test (dscf per unit time).

d = The fuel flow rate (mmscf per unit time for gaseous fuels, mgal per unit time for liquid fuels).

The exhaust flow rate shall be determined in consistent unit with fuel flow rate. For example, if C is measured as dscf per hour, d shall be measured as mmscf per hour or mgal per hour.

6. The criterion for acceptability of the average fuel sulfur content shall be a 95% confidence interval that the tested fuel sulfur contents shall be within 20% of the average fuel sulfur content. The average fuel sulfur content over a quarterly period shall be determined according to:

$$C_c = (1/n) \sum_{i=1}^{n} C_i \qquad \text{(Eq.28)}$$

$$S_c = [ \sum_{i=1}^{n} (C_i - C_c)^2 / (n-1) ]^{1/2} \qquad \text{(Eq.29)}$$

$$CC = t_{0.975} S_c/(n-1)^{1/2} \qquad \text{(Eq.30)}$$

$$C.I.\,(\%) = \frac{| CC |}{C_c} \qquad \text{(Eq.31)}$$

where:

$S_c$ = The standard deviation (wt. %, grain/100 $ft^3$, or ppmv).

i = Each weekly testing

n = The number of quarterly testing data points, measured once a week, to determine the average sulfur content throughout the quarterly period.

$C_i$ = The sulfur content (% wt., grain/100 $ft^3$, or ppmv) determined at each weekly testing sampled on a random basis.

CC = The confidence coefficient

$t_{0.975}$ = The t value determined from Table 4-A

$C_c$ = The average sulfur content (%wt., grain/100 $ft^3$, or ppmv) determined over a quarterly period.

C.I. = The confidence interval with 95 % confidence level (%)

**Table 4-A - Table of the Factor $t_{0.975,n-1}$ for Obtaining One-Tailed Confidence Interval for the Mean**

| n* | $t_{0.975}$ | n* | $t_{0.975}$ | n* | $t_{0.975}$ |
|---|---|---|---|---|---|
| 6 | 2.571 | 10 | 2.262 | 13 | 2.179 |
| 7 | 2.447 | 11 | 2.228 | 14 | 2.160 |
| 8 | 2.365 | 12 | 2.201 | 15 | 2.145 |
| 9 | 2.306 | | | | |

* The values in this table are already corrected for n-1 degrees of freedom. Use n equal to the number of individual values. 40 CFR Part 60, App B, Spec. 1.